Claims

1) An optical machine for creating an image of a master object on a format plane, including:

a first assembly defining a master object plane and a format plane in spaced apart positions;

a second assembly disposed between the master object plane and the format plane, for transferring successive parts of the image of the master object from the plane of the master object to the format plane;

a third assembly which moves the second assembly reciprocally in a first direction to provide a first dimension of an areal scan pattern;

a fourth assembly coupled to the first and second assemblies for moving the first assembly incrementally in a second direction orthogonal to the first direction between movements of the second assembly to provide a second dimension of the areal scan pattern.

2) An optical machine according to claim 1 for creating an image of a master object which is superimposed in registry upon another pre-existing image located in the format plane, wherein the first assembly includes means to incrementally move the master object relative to the format plane in a controlled manner.

3) An optical machine according to claim 1 in which the first assembly contains a photomask at the master object plane.

4) An optical machine according to claim 1 in which the first assembly contains a flexible material at the format plane.

5) An optical machine according to claim 4 in which the flexible material includes a material sensitive to exposure by actinic radiation on at least one side.

6) An optical machine according to claim 4 in which the flexible material is one of a class of materials comprising plastic, thin metal, and a composite membrane.

7) An optical machine according to claim 4 in which the flexible material bears a pre-existing image.

8) An optical machine according to claim 4 in which the flexible material is formed as a web and the system for feeding the web through the machine comprises a feed roller supplying the flexible material via one or more guide rollers to a take-up roller.

9) An optical machine according to claim 8 where the axes of the feed roller, the guide rollers and the take-up roller are aligned parallel to each other.

10) An optical machine according to claim 8 where are the axes of the feed, take-up and guide rollers are parallel and the web moves in directions that are perpendicular to the axes of said rollers.

11) An optical machine according to claim 4 including a vacuum platen coupled to the fourth assembly and backing up the flexible material.

12) An optical machine according to claim 11 wherein the portion of the flexible web comprising the format area is engaged tightly to the vacuum platen during completion of a raster scan pattern and moves together with the first assembly during the complete series of passes of the second assembly comprising the raster scan pattern.

13) An optical machine according to claim 1, wherein the second assembly comprises an optical transfer assembly.

14) An optical machine according to claim 13 in which the second assembly includes means to change the magnification of the transferred image in a controlled manner

15) An optical machine for creating an image of a master object on a format plane, including:

a first assembly defining a master object plane as a first component and a format plane as a second component, the two components being substantially coplanar and in spaced apart positions;

a second assembly comprising an optical transfer subsystem disposed between the object plane and the format plane, for sequentially transferring successive parts of the image of the master object from the plane of the master object to the format plane;

a third assembly comprising a drive mechanism which moves the second assembly reciprocally in a first direction to provide a first dimension of a raster scan pattern;

a fourth assembly comprising a drive mechanism coupled to the first and second assemblies for moving the first assembly incrementally in a second direction orthogonal to the first direction between reciprocations of the second assembly to provide a second dimension of the raster scan pattern;

a fifth assembly comprising a source of actinic radiation, light mixing means and drive means, part of which moves, coupled with the second assembly, to provide actinic radiation to the part of the image of the master object being transferred; and

a base structure supporting the five assemblies and providing flat and orthogonal reference surfaces for the movements of the first and second assemblies.

16) An optical machine according to claim 15 wherein the first assembly moves intermittently between reciprocating passes of the second assembly, and includes aerodynamic bearings referencing off the base structure, the first assembly being supported and retained to be orthogonal to the reciprocating motion of the second assembly.

17) An optical machine according to claim 15 in which the base structure comprises either stone or metal.

18) An optical machine according to claim 15 wherein the base structure includes a guide strip which is firmly mounted and the second assembly includes opposed air bearings referencing on the guide strip, and the reciprocating motion of the second assembly is thereby guided into a closely repeating path.

19) An optical machine according to claim 18 where the guide strip is straight and the closely repeating path followed by the second assembly is a straight-line path.

20) An optical machine according to claim 15, wherein the fifth assembly comprises at least a source of actinic radiation, an integrator rod, a transfer lens and a fiber bundle in series.

21) An optical machine according to claim 20 in which the source of actinic radiation is selected from the class comprising a filament lamp, a metal-halide arc, a mercury arc, a microwave excited source, an excimer laser, an ion laser, a light emitting diode, a solid state laser or a gas laser.

22) An optical machine according to claim 20 in which the fiber cable is a random arrangement of individual fibers whose exit end is shaped to illuminate the used field of the optical transfer assembly and which is driven to illuminate this field throughout the reciprocating pass of the optical transfer assembly.

23) A reflecting optical system for transferring an image from an object plane to an image plane at nearly unit magnification, comprising a concave mirror, a convex mirror and a concave mirror in series, the concave mirrors being spherical, of the same curvature, sharing approximately the same centers and being controllably movable with respect to each other for the purpose of introducing a slight change in magnification.

24) A reflecting optical system according to claim 23 fitted with a mechanism for moving the two concave mirrors small amounts in opposing directions aligned to the axis of the convex mirror in response to driver signals to change the system magnification.

25) A reflecting optical system according to claim 23 wherein the convex mirror is spherical.

26) A reflecting optical system according to claim 23 wherein the convex mirror is aspherical.

27) A reflecting optical system according to claim 23, fitted near to the object plane with an arctuate field stop, the common center of the arcs comprising the sides of the stop lying on the axis of the convex mirror, in order to admit through the reflecting optical system the arc of rays comprising best imagery.

28) A reflecting optical system according to claim 23 fitted at the object side with two orthogonally placed flat mirrors and at the image side with two orthogonally placed flat

mirrors, for inversion and reversion of the image, the system of flat mirrors combining with the inversion and reversion of the curved reflecting mirrors to produce an erect image.

29) A reflecting optical system according to claim 23 fitted at the object side with three orthogonally placed flat mirrors and fitted at the image side with three more orthogonally placed flat mirrors, the system of flat mirrors combining with the inversion and reversion of the curved reflecting mirrors to produce an erect image and to rotate the arc of rays comprising best imagery by 90 degrees.

30) A reflecting optical system according to claim 23, where the system of flat mirrors is arranged to substantially increase the distance between the center of the object plane and the center of the image plane.

31) An optical machine for creating an image of a master object on a format plane, including:

a first assembly defining a master object plane and a format plane in spaced apart positions;

a second assembly comprising a reflecting optical system wherein a concave mirror, a convex mirror and a concave mirror follow each other in series, the concave mirrors being spherical, of the same curvature, sharing approximately the same centers and being controllably movable with respect to each other for the purpose of introducing a slight change in magnification, for transferring successive parts of the image of the master object from the plane of the master object to the format plane at nearly unit magnification;

a third assembly which moves the second assembly in a reciprocating motion in a first direction to provide a first dimension of an areal scan pattern;

a fourth assembly coupled to the first and second assemblies for moving the first assembly incrementally in a second direction different from the first between movements of the second assembly to provide a second dimension of the areal scan pattern.

32) An optical machine according to claim 31 including three air/vacuum bearings supporting the reciprocating motion of the second assembly, one bearing located generally under the object plane, one bearing located generally under the image plane, and the third bearing located under the centerline of the convex mirror, removed from the first two bearings to form a triangular support.

33) An optical machine according to claim 32 further including two autofocus gages, each generating an error signal, one gage located close to the object plane, monitoring the distance of the object plane from the photomask plane and the other gage located close to the image plane, monitoring the distance of the image plane from the format plane.

34) An optical machine according to claim 33 wherein there are three servoed lifters, one above each of the air/vacuum bearings under the object and image planes, wherein each lifter's movement is responsive to the error signal of the autofocus gage under its respective plane, and the third servo lifter above the rear air/vacuum bearing, its drive signal being generated as the average of the signals driving the other two lifters.

35) An optical machine according to claim 31 including a mounting frame movably supporting the photomask and comprising drivers to permit slight controlled movement in two orthogonal directions, both directions lying within the object plane.

36) An optical machine according to claim 31 for creating an image of a master object which is superimposed in registry upon another pre-existing image located in the format plane.

37) An optical machine according to claim 36, also comprising position sensitive gages carried on the second assembly which read fiducial marks on the photomask and on a preexisting format image.

38) A method of transferring images wherein an optical machine includes fiducial marks on a photomask and on a preexisting image and the optical machine undergoes successive raster passes comprising the steps of reading some fiducial marks on the photomask and fiducial marks on a pre-existing format image at the start of each raster pass, and reading additional fiducial marks on the photomask and on the format image at the end of each pass, and deriving from the readings knowledge of the distortion existing between selected positions on the photomask in X and Y relative to corresponding positions on the pre-existing format image, and from this knowledge developing driver control signals to progressively move the photomask within its frame during each reciprocating pass of the second assembly.

39) A method in accordance with claim 38, wherein the photomask undergoes slight movement in both X and Y within its frame during a raster pass, in response to driver signals to minimize positional mismatch during the pass between the centers of successive object fields on the master photomask object and the centers of corresponding successive image fields on the preexisting distorted format image.

40) A method in accordance with claim 38 wherein fiducial marks on the photomask and fiducial marks on a pre-existing format image are read at the start of each raster pass, and additional fiducial marks on the photomask and on the pre-existing format image are read at the end of each pass, from the readings knowledge is derived of the magnification error existing between selected positions on the photomask in X and Y at the start of successive raster passes relative to corresponding positions on the pre-existing format image, and from this knowledge driver control signals are developed to adjust the magnification of the optical transfer assembly at the start of each raster pass.

41) A method in accordance with claim 40 in which the optical transfer assembly comprises two concave mirrors and a convex mirror, and the method includes the steps of moving the concave mirrors incrementally in opposite directions aligned to the axis of the convex mirror at the start of each raster pass to adjust the magnification to compensate the extremes of the instantaneous field for measured Δx and Δy magnification errors.

42) A system for recording images on a recording web disposed in a substantially planar disposition between a take-up side and a supply side and comprising:

an areal platen disposed along the web and engageable to a substantial portion of the surface thereof;

an imaging system disposed between a master object plane and a format plane along the width of the web, the imaging system including an illuminating source and optics providing a controllable beam for illuminating an object plane with a portion of an image of the master object;

an optical transfer assembly for projecting an image of the master object across the web toward the format plane;

a first drive for reciprocating the optical transfer assembly along a first direction substantially equal to the width of the web such that a first direction of raster scan is provided at the format plane;

a second drive system engaging the vacuum platen for moving the web laterally relative to the first direction to provide a two dimensional raster action at the format plane, and

a third drive means for the recording web for repetitively delineating images of the complete master object on successive segments of the web.

43) A system for providing precision images of the object on a photomask comprising:

a web transport system for moving an image web substantially without twisting in a path between a supply region and a take-up region;

a web handling device along the web transport system comprising a vacuum platen engaged against a region of the web and controllably movable along the direction of movement of the web;

an imaging assembly disposed adjacent the web and including a light source, an optical magnification system, and focusing optics disposed in a multi-reflective path extending across the web path, the imaging assembly being disposed to project an image of a portion of the photomask at an objective position on the web;

a control system for scanning the imaging assembly across a portion of the photomask in the direction across the web, and a control system for shifting the web incrementally longitudinally relative to the direction of movement of the optical imaging assembly so as to provide a two-dimensional raster image of the photomask image.

44) An optical projection system for recording images on a photomask serially on a recording web, wherein the recording web is advanced substantially without twisting between supply and takeup sides, comprising:

a web transport system for advancing the web between supply and takeup locations;

an imaging assembly disposed adjacent the web path, the assembly including a radiation source for illuminating a portion of the photomask, and optics defining a multiply refolded light path, and including magnification and focusing controls varying the path length of the fields, the light path leading to a format position on the web;

a first raster scanning drive moving the imaging assembly along a first axis across the web to provide a first raster scan direction;

a second raster scanning drive moving the web laterally to the first raster scan direction in timed relation to the first raster scan movement, and

a control system for advancing the web an incremental distance when a complete raster has been provided.

45) The method of providing high precision images on an optical recording medium corresponding to a master image, comprising the steps of:

extending the recording medium along a recording plane, periodically advancing the recording medium along the plane to successive recording positions;

illuminating a part of the master object to provide an image beam;

repetitively scanning the illuminated part of the master object onto an area of the recording medium, with the recording medium stationary;

shifting the recording medium laterally between scans to provide a two dimensional image on the medium, and

advancing the medium along the recording plane when the two dimensional image has been formed.

46) The method of optically reproducing the image of a master element with high resolution on a recording medium, comprising the steps of:

holding the recording medium steady for an image reproduction interval;

generating an image beam in the optical assembly which projects a small part of the master element on the recording medium;

scanning the generated image beam along the recording medium for a selected distance in a first direction;

repeating the scanning in the first direction after shifting the recording medium in a second direction lateral to the first; and

advancing the recording medium after a substantially complete raster image of the master element has been formed.

47) The method of creating at a format plane the image of a master object comprising the steps of:

momentarily holding a recording element stationary at a format plane in a given planar position;

projecting, with an optical transfer assembly of chosen magnification, an image of an incremental part of the master object onto the format plane;

scanning the master object from one end to the other along a first direction by moving the optical transfer assembly;

reciprocating the optical transfer assembly back to the first end after shifting the planar position of the recording element perpendicularly relative to the first direction, and

repeating the scanning steps until a complete image of the master object is formed on the recording element.